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**GAY GULCH AND SKOOKUM
METEORITES**

by

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Gay Gulch and Skookum Meteorites.

By R. A. A. JOHNSTON.

The meteorites which form the subject of this article are two irons discovered in the course of gold mining operations on two of the gulches tributary to the Bonanza Creek system, Klondike mining district, Yukon, Canada.


GAY GULCH.

The first of these meteorites was found in 1901 in one of the sluice boxes on No. 6 claim on Gay gulch—latitude $63^{\circ} 54'$ N. longitude $139^{\circ} 16'$ W.—and was obtained by the Geological Survey from Mr. J. B. Tyrrell, mining engineer, in 1906. Gay gulch, as may be seen from the diagram, enters Eldorado creek from the eastward at a point a little more than 3 miles in a direct line above the junction of the latter with Bonanza creek, or a little less than 13 miles in a south-southeasterly direction from the town of Dawson. Here, as on other gulches in the district, the gravels—white channel gravels—lying on bed-rock were being washed for gold, and the specimen must, therefore, have been lying either in contact with bed-rock or at the most not more than 2 or 3 feet above it. Emphasis is laid upon this fact here as it has an important bearing on the discussion, to follow later, on the probable geologic age of the meteorites under consideration.

The Gay Gulch iron, previous to the removal of a small end piece, weighed 483 grammes. The general form and size of the

specimen are illustrated in Plate I. It showed unmistakeable evidence of having been subjected to attrition with other substances and there were no signs of the pittings to be observed on meteorites of recent fall. The surface was covered with a thin scaly crust of rusty materials. On one portion of the surface a natural etching has been produced forming a network of coarse rhombohedral figures. An average sized figure measures 3 centimetres in length by 2 centimetres in width. These figures are not in evidence on an artificially polished and etched surface except at one point where the etching shows to a depth of 2 millimetres from the edge. It would seem as if the original mass had been far from homogeneous and that the specimen we now have may be in the nature of a core left by the removal by attrition and oxidation of less resistant materials.

A polished and etched plate presents little that is plain to the unaided eye. The surface is clouded and exhibits a dull chatoyancy when the plate is viewed at different angles with respect to the line of vision, the different shades alternating between light and dark grey. On one portion of the plate there appears a very thin zigzag streak of a silver-white substance having a bright metallic lustre, the identity of which is doubtful. In some respects it resembles schreibersite, but it possesses a greater degree of cohesion than is common with schreibersite.

 When examined under a moderate power of the microscope in a direction normal to its plane the plate presents a fine microgranular groundmass broken by abundant narrow trough-like pittings, generally tapering at each end. Over most of the plate these pittings are seen to be disposed with more or less regularity along three directions; these features are clearly illustrated in the photomicrograph, Plate II. Near the zigzag inclusion to which reference has been made the pittings exhibit no regular arrangement and their forms are not clearly defined as are those on the rest of the plate. Their irregular arrangement and forms are illustrated in the photomicrograph, Plate III.

When viewed obliquely the pittings are seen to be bounded by thin envelopes of a silver-white metallic substance. The same substance also shows in numerous points, and rarely in lath like forms, over portions of the plate. Its identity cannot

be determined with accuracy, but it is probably referable to lamprite.

The general distribution of these pittings along directions parallel with the faces of the octahedron is strongly suggestive of an octahedral structure for this iron. If this iron should eventually prove to be an octahedrite it is remarkable for the high percentage of nickel which it contains as indicated by a partial analysis conducted in the laboratory of the Mines Branch of the Department of Mines by Mr. H. A. Leverin, who found for it the following figures: iron 83.85, nickel 15.03. The specific gravity as determined by the author was found to be 7.566.

SKOOKUM.

The second specimen was found January 21, 1905, by Mr. W. Kast, on claim No. 7, Skookum gulch—latitude $63^{\circ} 56'$ N. longitude $139^{\circ} 20'$ W. By reference to the diagram it will be observed that this gulch enters Bonanza creek about half a mile below Eldorado Forks, and approximately $9\frac{1}{2}$ miles in a southeasterly direction from the town of Dawson. At the time of the discovery, claim No. 7 was being worked under the terms of a lease and a dispute arose over the ownership of the meteorite. An agreement was after a time effected, by which Mr. Kast retained possession and he afterward exhibited the specimen at the Alaska-Yukon-Pacific exposition at Seattle, Wash., U.S.A., in 1909, where it was secured for the Museum of the Geological Survey by the late Mr. R. L. Broadbent.

This iron was encountered in white channel gravels 65 feet below the surface of the ground and between 2 and 3 feet above bed-rock. In form it was, roughly speaking, a block varying in thickness from 3 to 8 centimetres and exhibiting an irregular pentagonal outline; it measured 29 centimetres in length by 23 in width and weighed 15.88 kilogrammes. It was characterized by a number of broad and shallow depressions, one of which had a breadth of 21 centimetres with a maximum depth of 2 centimetres. These depressions were further marked by abundant small pittings. The exterior character of this iron is well illustrated in Plates IV, V, and VI. Portions of the surface had

a glossy appearance approaching that of a newly fallen meteorite, but on close examination this was found to be due to polishing of an oxidized surface by contact with the materials making up the gravels. The general surface colour is dark brown to brownish-black and is due to the coating of oxidized material which encrusts the specimen.

This iron has recently been sliced, polished, and etched by the Foote Mineral Company, Philadelphia, Pa., to whom the writer is indebted for permission to use the photographs of one of the etched plates. The slicing revealed the presence of a number of inclusions of troilite, most of which were quite round and of small dimensions—1 to 5 millimetres in diameter; another irregularly formed one measured 24 millimetres in length by 12 in width. One of these nodules, measuring 3 millimetres in diameter, is shielded on one side by a thin covering of a white metallic substance identical in appearance with an inclusion noted in the Gay Gulch iron; on the side of the nodule opposite to this shield the iron is marked by a number of cooling cracks. Another minute inclusion of this same white metallic substance is to be seen in another part of the plate near one edge; the iron surrounding this inclusion is likewise marked by a number of cooling cracks. The first of these inclusions is shown together with portions of the cooling cracks in Plate VII. The treatment of the polished slice failed to develop any etch figures properly so called. There was developed, however, a peculiar chatoyant effect which is to be seen by holding the plate at different angles to the line of vision. Thus when the plate is held in one position certain portions appear quite dark while the remaining portions appear bright, but if the plate be rotated through an angle of between 50 and 60 degrees, the eye of the observer being kept in the same position, the positions of these dark and light portions become reversed, that is to say, what was dark in the first position becomes light in the second position. This property which is illustrated in Plates VIII and IX is clearly due to a definite crystallographic arrangement, and is strongly suggestive of octahedral twinning.

Under moderate powers of the microscope the etched plate is seen to vary in character in different portions. Near the inclusion

of troilite, with which is associated the white unidentified metallic substance to which attention has already been called, it presents only a microgranular structure in which the individual grains are barely discernible (Plate VII). Near the larger troilite inclusions there is still presented the same microgranular structure but the plate is marked by an abundance of small pittings, some nearly circular in outline, some narrow and elongated, and still others showing no definite form and all distributed apparently with regard to no definite system of arrangement (Plate X). Distant from the troilite inclusions the etched plate presents the same microgranular structure marked by pittings of the same kind as those observed in proximity to the troilite (Plate XI), but here the pittings display some tendency to arrange themselves in well defined directions parallel with the faces of the octahedron as in the case of Gay gulch; the pittings are, however, much smaller than those observed in Gay gulch, but like them they are seen, when viewed obliquely, to be bounded by thin envelopes of a silver white metallic substance. Points and occasional lath-like forms of the same substance are also to be observed scattered over the surface.

The Skookum iron has been analysed recently by Mr. J. E. Whitfield in the laboratory of Messrs. Booth, Garrett, and Blair, Philadelphia, Pa., and he reported it to have the following composition:

Silicon.....	0.003
Sulphur.....	0.002
Phosphorus.....	0.194
Manganese.....	none
Carbon.....	0.015
Chromium.....	0.002
Copper.....	none
Nickel.....	18.200
Cobalt.....	0.910
Iron.....	80.650
	<hr/>
	99.976

The specific gravity as determined by the author was found to be 7.561.

GEOLOGICAL HISTORY.

The country in which Gay Gulch and Skookum meteorites were found has been geologically surveyed by Mr. R. G. McConnell, Deputy Minister of Mines, Canada, whose report thereon is to be found in the Annual Report of the Geological Survey of Canada, Vol. XIV, 1901, part B. In this report Mr. McConnell devotes considerable attention to the character and origin of the auriferous gravels for which the Klondike district is famous; these he classifies as low-level gravels, gravels of intermediate levels, and high-level gravels, the high-level gravels being the oldest. These high-level gravels are further subdivided into river gravels and "white channel" gravels, the latter being the older. The term "white channel" is a miners' designation given to the gravels by reason of their appearance and distribution. The "white channel" gravels are ancient creek deposits varying from a few feet to 150 feet in depth. They consist of a "compact matrix of small, clear, little-worn and often sharply angular grains of quartz, pebbles, and rounded sub-angular and wedge-shaped quartz boulders often two or three feet in diameter. Flat and sub-angular pebbles of sericite schist, the principal rock of the district, are also present, but in much smaller numbers than the quartz constituents. The schist pebbles are usually decomposed and crumble rapidly when thawed out. The deposit is indistinctly stratified, but, except in rare instances, there has been no complete sorting of the various constituents into separate beds and the composition is very uniform throughout. The colour is characteristically white or light grey due to the preponderance of the quartz constituents and the leaching out of the greater part of the iron."

From the position of the Gay Gulch and Skookum meteorites at or close to bed-rock, it is natural to conclude that they must have been laid down in the positions in which they were discovered in the earliest stages of deposition of the "white-channel" gravels. These "white-channel" gravels, according to Mr. McConnell's estimate, date back to Pliocene time at least. The probability is, therefore, that these two meteorites like the gravel deposits in which they were embedded date back

to Pliocene time at least and that their actual descent antedates even this period.

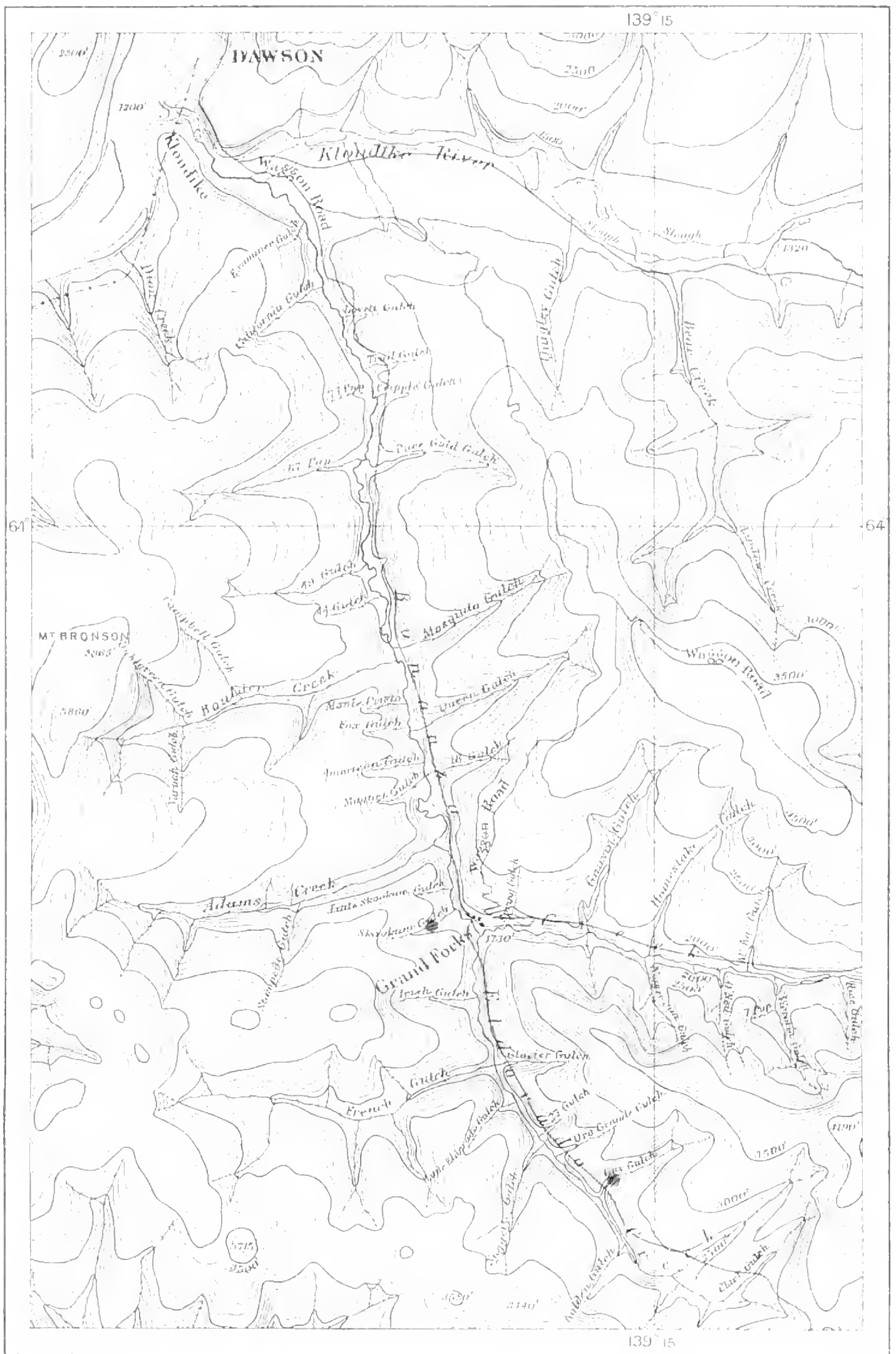
CONCLUSION.

While the evidence may not be entirely conclusive there is much to support the theory that these two meteorites are individuals belonging to a single shower. That they can be detached fragments of a single mass reaching the earth as such seems out of the question; a glance at the diagram will show that any natural movements to which they have been subjected since reaching the earth would tend to bring them nearer together. On the other hand an examination of the contours as outlined on the diagram will show that it is highly improbable that the distance between the points of contact could have been greater than 10 miles, an interval which has been greatly exceeded in the case of some observed showers. The strongest evidence of the identity of the two meteorites rests, however, with their general structure and composition. They both belong to a comparatively limited series of nickel-rich meteorites. Of 215 iron meteorites whose analyses are quoted by Farrington¹ only 58 showed nickel-cobalt contents of 10 per cent or over. The difference of 4.08 per cent is not greater than that sometimes found to exist between the nickel-cobalt contents of different parts of the same mass. The nickel-cobalt content of Shingle Springs has been shown to vary from 8.88 per cent to 17.17 per cent; that of the Troost iron (Babbs Mill) from 9.76 per cent to 19 per cent; that of the Blake iron (Babbs Mill) from 7.95 per cent to 14.24 per cent; that of Illinois gulch from 6.86 per cent to 13.48 per cent. In their general structure they present certain features common to both which seem unique among nickel-rich irons: their tendency to follow a definite crystallographic arrangement constitutes in particular a most unusual property in meteorites of this kind. They both exhibit the same peculiar cloudiness and chatoyancy. A comparison of the photomicrographs (Plates II, III, X, and XI) will show the

¹Analyses of Iron Meteorites, compiled and classified, Field Columbian Museum, Chicago, Vol. 3, No. 5.

striking similarity between the two. They both exhibit a microgranular groundmass broken by a series of fine pittings and it is only in the relative size of these pittings that they exhibit any apparent structural variation; but it must be remembered that this variation in the dominant character of the two meteorites is in the main not greater than the variations to be observed in the character of different parts of either one of them.

All of these factors which have just been noted together with the very probable coincidence in point of geologic age point strongly to the probability that these irons are relics of a single meteoric shower which took place back in Tertiary time.



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Diagram of Bonanza Creek, Yukon, showing localities of discovery of Gay Gulch and Skookum meteorites

Scale of miles



EXPLANATION OF PLATE I.

These two figures represent opposite sides of the Gay Gulch iron—natural size.

A—Showing natural etching of a part of the surface. The figure is that of a coarse octahedrite.

B—Showing the opposite side of the specimen with no traces of etching



A.



B.

EXPLANATION OF PLATE II.

Polished and etched section of Gay Gulch iron—magnified 50 diameters—showing the microgranular groundmass broken by elongated pittings distributed parallel with the faces of the octahedron.



EXPLANATION OF PLATE III.

Polished and etched section of Gay Gulch iron—magnified 50 diameters—showing confused arrangement of pittings in the neighbourhood of troilite nodule.



EXPLANATION OF PLATE IV.

View of one surface of Skookum iron showing broad depression with small pittings.



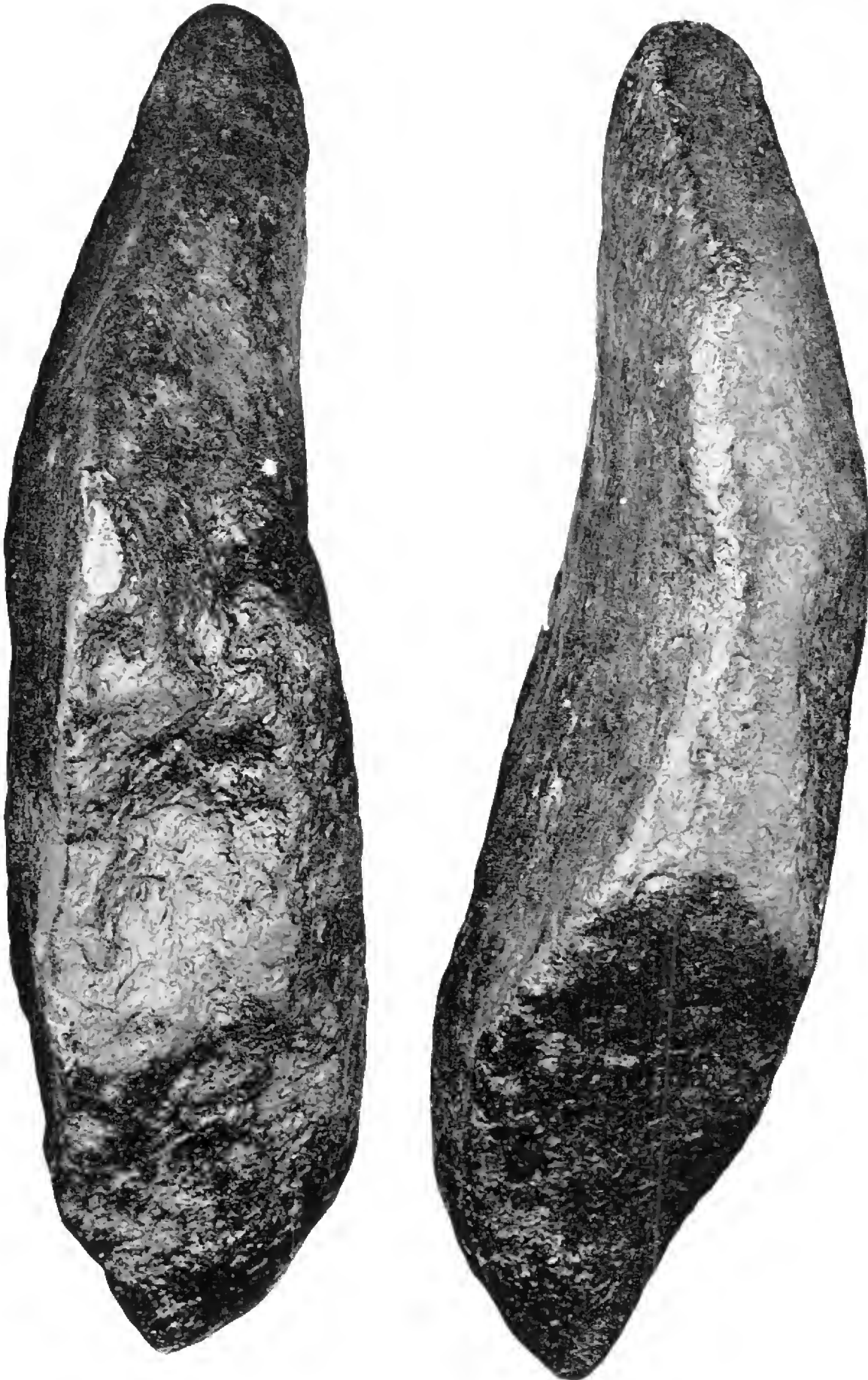
EXPLANATION OF PLATE V.

Surface of Skookum iron showing rusty incrustation.



EXPLANATION OF PLATE VI.

Lateral views of Skookum iron.



EXPLANATION OF PLATE VII.

Polished and etched section of Skookum iron—magnified 10 diameters. The dark mass in the centre is a small troilite nodule. Partially enclosing this nodule on the lower side may be observed the outline of a shield of a white unknown mineral. Radiating irregularly from the nodule are cooling cracks in the iron itself.



EXPLANATION OF PLATE VIII.

Etched plate of Skookum iron showing chatoyancy from first position.
Note octahedral outline of lighter shades.

Reproduced by kind permission of the Foote Mineral Company.



EXPLANATION OF PLATE IX.

Etched plate of Skookum iron showing chatoyancy from second position.
Note distinct octahedral figures over a large part of the plate.

Reproduced by kind permission of the Foote Mineral Company.



EXPLANATION OF PLATE X.

Polished and etched section of Skookum iron in proximity to troilite inclusion—magnified 50 diameters—showing microgranular groundmass with confused distribution of pittings.



EXPLANATION OF PLATE XI.

Polished and etched section of Skookum iron—magnified 50 diameters—showing ordinary structure. Microgranular groundmass broken by pittings. The tendency toward a regular arrangement of certain of the pittings along directions parallel with the faces of the octahedron is noticeable.



The first number of the Museum Bulletin was entitled, *Victoria Memorial Museum Bulletin, Number 1*.

The following articles of the Geological Series of Museum Bulletins have been issued.

Geological Series.

1. The Trenton crinoid, *Ottawacrinus*, W. R. Billings; by F. A. Bather.
2. Note on *Merocrinus*, Walcott; by F. A. Bather.
3. The occurrence of Helodont teeth at Roche Miette and vicinity, Alberta; by L. M. Lambe.
4. Notes on *Cyclocystoides*; by P. E. Raymond.
5. Notes on some new and old Trilobites in the Victoria Memorial Museum; by P. E. Raymond.
6. Description of some new Asaphidæ; by P. E. Raymond.
7. Two new species of *Tetradium*; by P. E. Raymond.
8. Revision of the species which have been referred to the genus *Bathyurus* (preliminary paper); by P. E. Raymond.
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10. A new genus of dicotyledonous plant from the Tertiary of Kettle river, British Columbia; by W. J. Wilson.
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12. Prehnite from Adams sound, Admiralty inlet, Baffin island, Franklin; by R. A. A. Johnston.
13. The origin of granite (micropegmatite) in the Purcell sills; by S. J. Schofield.
14. Columnar structure in limestone; by E. M. Kindle.
15. Supposed evidences of subsidence of the coast of New Brunswick within modern time; by J. W. Goldthwait.
16. The Pre-Cambrian (Beltian) rocks of southeastern British Columbia and their correlation; by S. J. Schofield.
17. Early Cambrian stratigraphy in the North American Cordillera, with discussion of the Albertella and related faunas; by L. D. Burling.
18. A preliminary study of the variations of the plications of *Parastrophia hemiplicata*, Hall; by A. E. Wilson.
19. The Anticosti Island faunas; by W. H. Twenhofel.
20. The Crowsnest Volcanics; by J. D. Mackenzie.
21. A *Beatricea*-like organism from the middle Ordovician; by P. E. Raymond.
22. The Huronian formations of Timiskaming region, Canada; by W. H. Collins.
23. Physiography of the Beaverdell map-area and the southern part of the Interior plateaus; by L. Reinecke.
24. On *Eoceratops canadensis*, gen. nov., with remarks on other genera of Cretaceous horned dinosaurs; by L. M. Lambe.
25. The occurrence of glacial drift on the Magdalen islands; by J. W. Goldthwait.